Personalized real-time EMG-informed neuromusculoskeletal models of tissue loading for neuromodulation by D. Lloyd

Motivation for statement on why this topic is relevant to neurorehabilitation:
To predict body movement and activity/stage in a virtual environment which may facilitate further application and rehabilitation in reality, e.g. find the most optimal way to facilitate and treat Achilles Tendonopathy. Therefore the topic is of great relevance since this may help to model further disabilities/difficulties in the human body movement and joint moment and position. This can be of great importance for several people to have new neurorehabilitation possibilities after injuries or diseases.

Short background:
It is very important to have good computer models of tissue loading for neuromodulation. Formerly several kinds of models have been used such as finite element models, rigid body neuromusculoskeletal models, and segmental models. When we use models only with muscles as input, there is a great muscular redundancy. Therefore there are is need for neural driven solutions. For the models available today, the optimization will lead to one neural solution, for the joint moment and position, but there are several different solutions that are possible.
Therefore the software CEINMS are proposed to be a new tool for optimizing models of tissue loading. The CEINMS has several different modes that can be used for optimizing these models. With this the predicted and measured joint movement is very close to each other. The first models developed were with 1 DoF, now it is working with 6 DoF, and it is actually more accurate and correct with several DoFs.
The problem with this have been the difference between scaled-generic musculoskeletal modes are that they over predict, but this can be solved by using subject specific input to calibrate the model, where it gets much more specific. The models have been tested in both infants and adults, with very good results.
These models can e.g. be used for Achilles Tendinopathy. Here they have found the goldy lock strain at 6 %. By using this 6 % there are an increase in collagen 1 (which is beneficial), it will decrease the max breaking, and there will be an increase in anabolic growing. If you go above the 6 % partial rupture can take place and below 6 % micro rupture can take place.

Discussion on challenges and likely future directions:
Future directions could be to optimize the subject specificity of the models to improve the further use. Besides this it could be a further improvement to have each person to have their own subject specific models to improve their rehabilitation. Other possibilities could be to try clinical application an validate this application.
A challenge and future perspective could be to not only use the models to predict joint moment and positions, but also to apply this to exoskeletons, where they might be able to give input on how the

exoskeleton should move, in order to have more normal behavior walking. The models could maybe also be used to develop new and better exoskeletons, which can be used for neurorehabilitation.